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(54) **ELECTRONIC DEVICE**

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(51) **Int. Cl.**

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G06F 1/28	(2006.01)
G06F 1/30	(2006.01)
G06F 1/00	(2006.01)

(52) **U.S. Cl.**

CPC ***G06F 1/3287*** (2013.01); ***G06F 1/263*** (2013.01); ***G06F 1/28*** (2013.01); ***G06F 1/30*** (2013.01); *G06F 1/00* (2013.01)

(58) **Field of Classification Search**

CPC G06F 1/3287
USPC 713/324
See application file for complete search history.

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(57) **ABSTRACT**

An electronic device comprises a main battery used as a drive power source for driving the electronic device, a secondary battery used as a drive power source instead of the main battery when the main battery cannot be used, a battery detection unit that detects an event of removal of the main battery from the electronic device, and a power control unit that changes the drive power source from the main battery to the secondary battery and controls operation of the electronic device to reduce power consumption by the electronic device when removal of the main battery is detected by the battery detection unit.

9 Claims, 7 Drawing Sheets

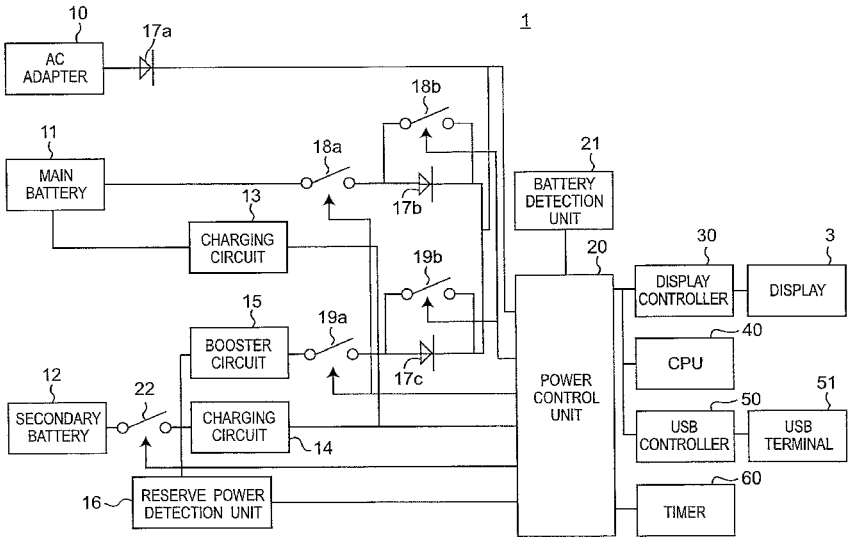


Fig.1

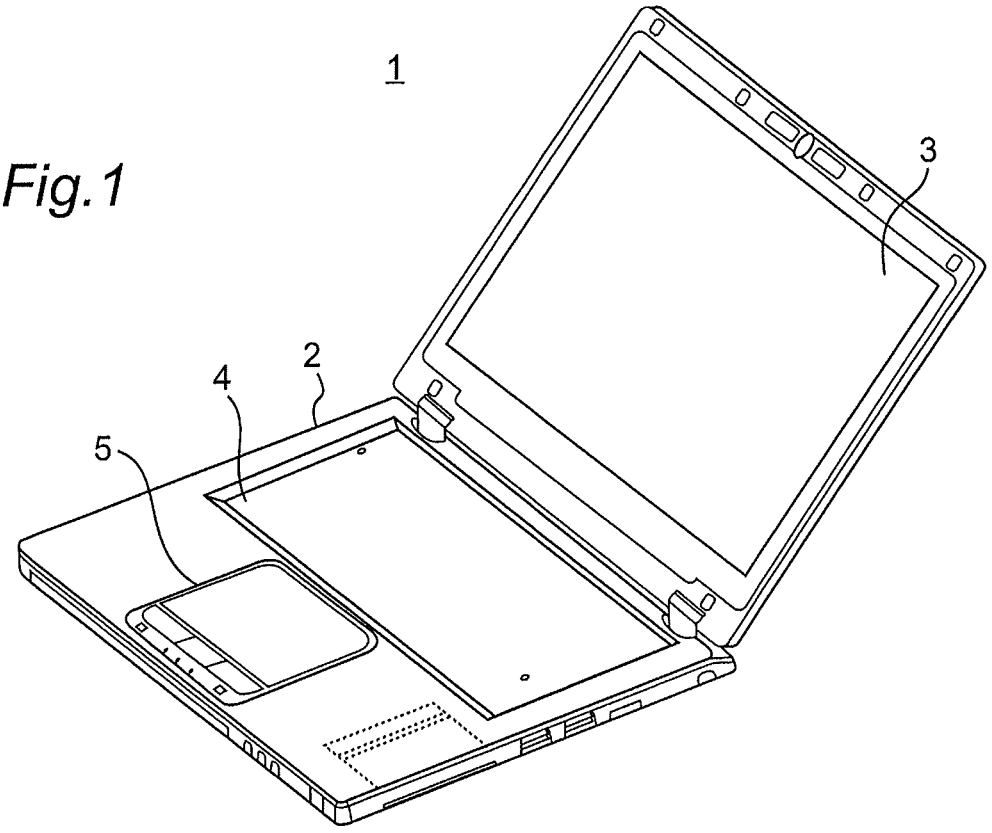


Fig.2

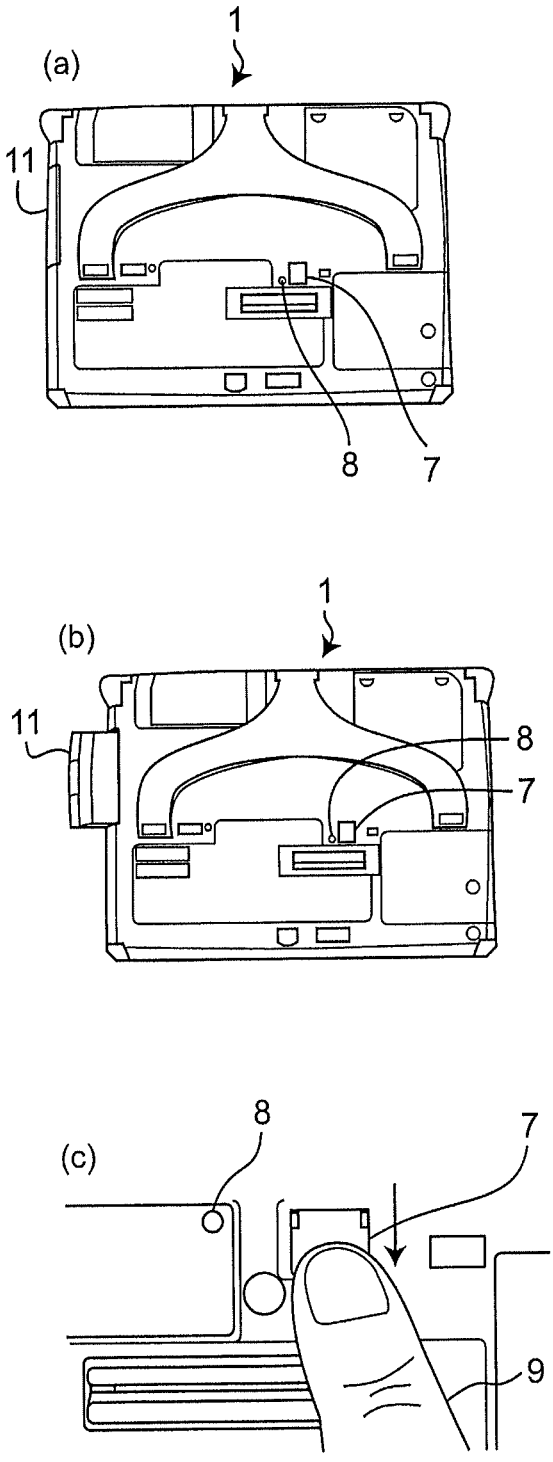


Fig. 3

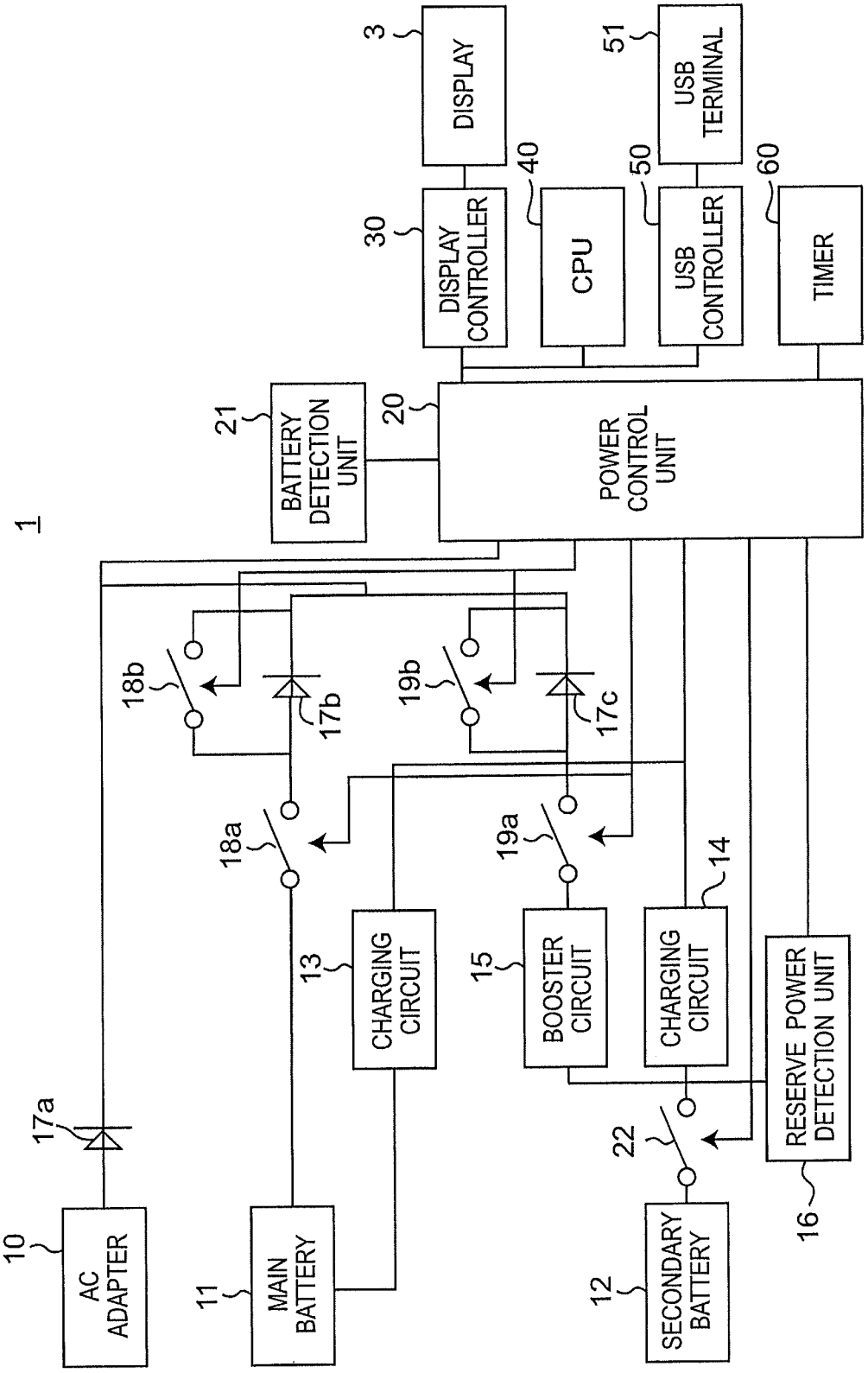

1
10
AC ADAPTER
17a
11
MAIN BATTERY
18b
17b
18a
13
CHARGING CIRCUIT
19b
17c
19a
15
BOOSTER CIRCUIT
14
CHARGING CIRCUIT
22
12
SECONDARY BATTERY
16
RESERVE POWER DETECTION UNIT
21
BATTERY DETECTION UNIT
20
POWER CONTROL UNIT
30
DISPLAY CONTROLLER
40
CPU
50
USB CONTROLLER
60
TIMER
3
DISPLAY
51
USB TERMINAL

Fig.4

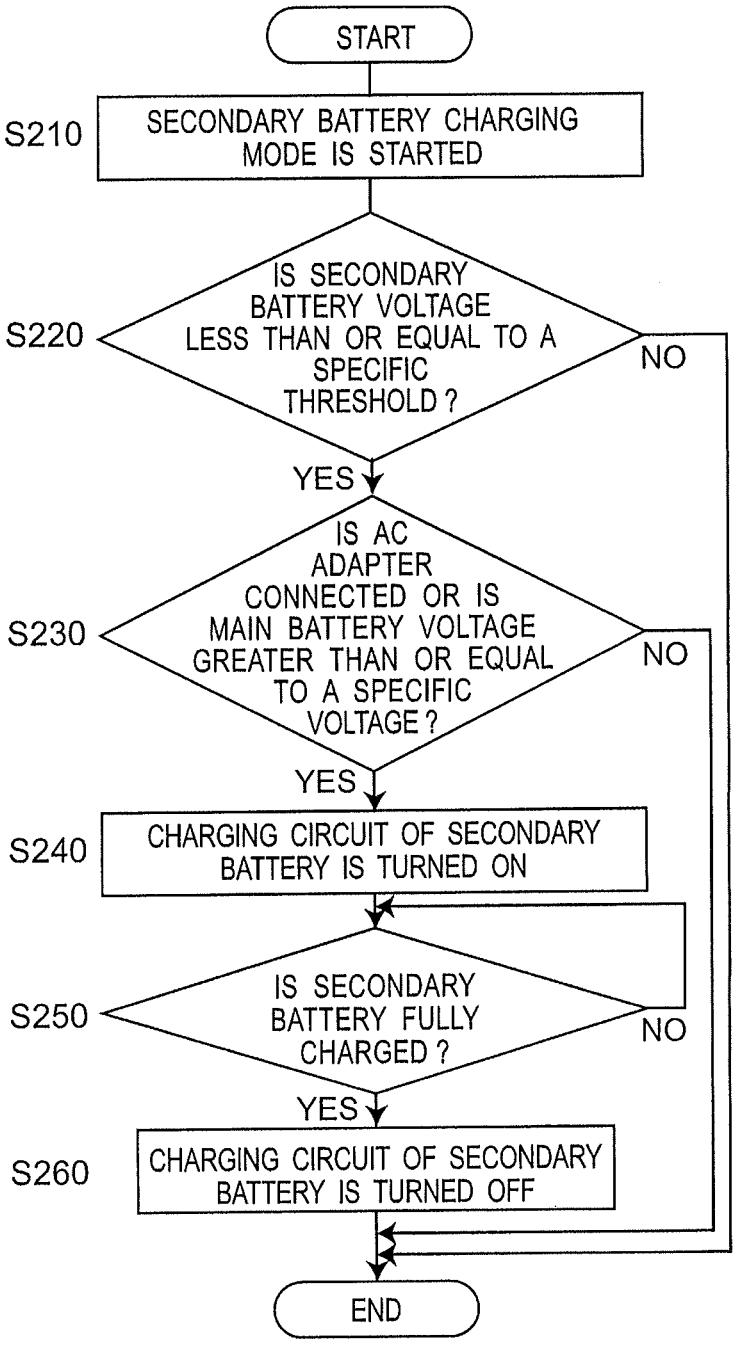

START
S210
SECONDARY BATTERY CHARGING MODE IS STARTED
S220
IS SECONDARY BATTERY VOLTAGE LESS THAN OR EQUAL TO A SPECIFIC THRESHOLD ?
NO
YES
S230
IS AC ADAPTER CONNECTED OR IS MAIN BATTERY VOLTAGE GREATER THAN OR EQUAL TO A SPECIFIC VOLTAGE ?
NO
YES
S240
CHARGING CIRCUIT OF SECONDARY BATTERY IS TURNED ON
S250
IS SECONDARY BATTERY FULLY CHARGED ?
NO
YES
S260
CHARGING CIRCUIT OF SECONDARY BATTERY IS TURNED OFF
END

Fig.5

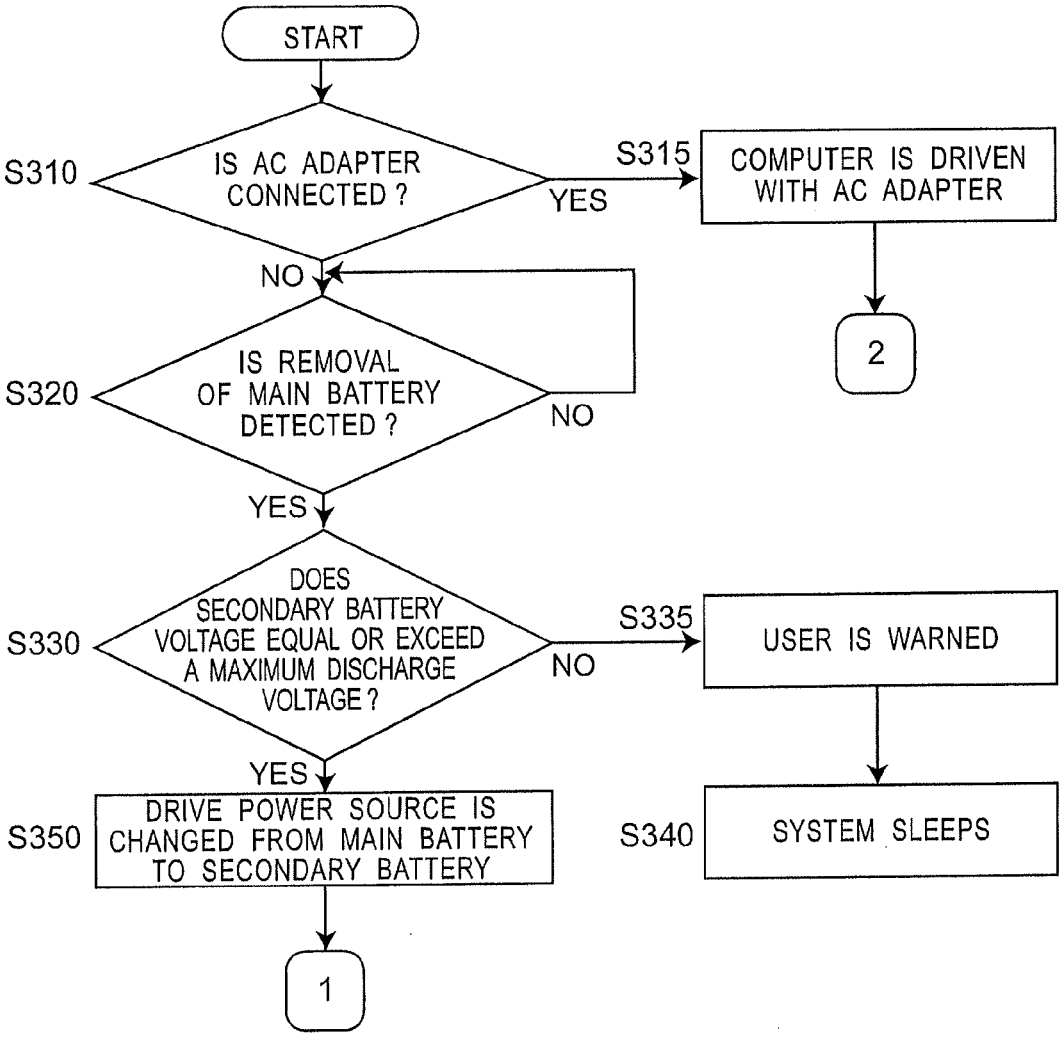

START
S310
IS AC ADAPTER CONNECTED ?
YES
S315
COMPUTER IS DRIVEN WITH AC ADAPTER
2
NO
S320
IS REMOVAL OF MAIN BATTERY DETECTED ?
NO
YES
S330
DOES SECONDARY BATTERY VOLTAGE EQUAL OR EXCEED A MAXIMUM DISCHARGE VOLTAGE ?
NO
S335
USER IS WARNED
S340
SYSTEM SLEEPS
YES
S350
DRIVE POWER SOURCE IS CHANGED FROM MAIN BATTERY TO SECONDARY BATTERY
1

Fig.6

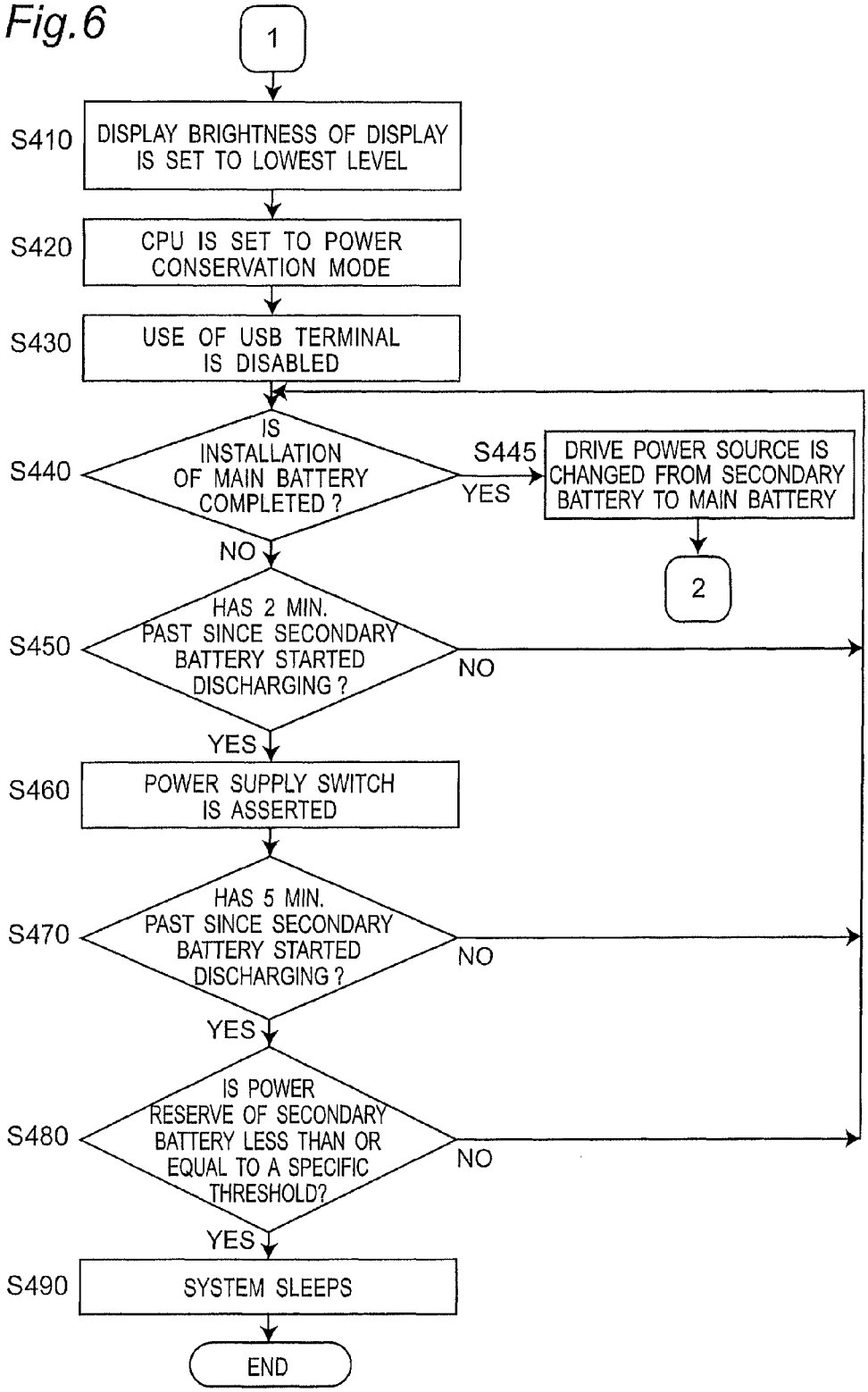
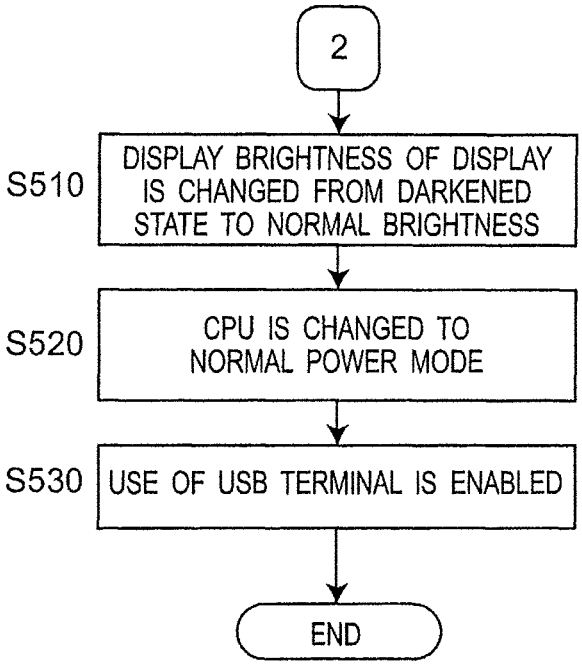

1
S410
DISPLAY BRIGHTNESS OF DISPLAY IS SET TO LOWEST LEVEL
S420
CPU IS SET TO POWER CONSERVATION MODE
S430
USE OF USB TERMINAL IS DISABLED
S440
IS INSTALLATION OF MAIN BATTERY COMPLETED ?
YES
S445
DRIVE POWER SOURCE IS CHANGED FROM SECONDARY BATTERY TO MAIN BATTERY
2
NO
S450
HAS 2 MIN. PAST SINCE SECONDARY BATTERY STARTED DISCHARGING ?
NO
YES
S460
POWER SUPPLY SWITCH IS ASSERTED
S470
HAS 5 MIN. PAST SINCE SECONDARY BATTERY STARTED DISCHARGING ?
NO
YES
S480
IS POWER RESERVE OF SECONDARY BATTERY LESS THAN OR EQUAL TO A SPECIFIC THRESHOLD?
NO
YES
S490
SYSTEM SLEEPS
END

Fig.7


2
S510
DISPLAY BRIGHTNESS OF DISPLAY IS CHANGED FROM DARKENED STATE TO NORMAL BRIGHTNESS
S520
CPU IS CHANGED TO NORMAL POWER MODE
S530
USE OF USB TERMINAL IS ENABLED
END

ELECTRONIC DEVICE

BACKGROUND

1. Technical Field

The present disclosure relates to an electronic device that is powered by a battery, and relates more particularly to an electronic device that can continue operating on a secondary battery even when the main battery is removed for replacement, for example.

2. Related Art

JP 2003-101624A discloses a portable terminal that has a detector for detecting installation and removal of a battery pack (main battery), and a selector that can switch the power source required for operation of the portable terminal between the battery pack and a backup battery (secondary battery) based on output from the detector. This portable terminal is also configured to monitor the remaining power of the backup battery (the remaining battery capacity), and execute a shutdown process when the remaining power goes to or below a specific threshold.

The portable terminal disclosed in JP-A-2003-101624 enables the user to replace the battery pack while continuing to use the terminal for data input, for example, by means of the backup battery, and prevents loss of data while the battery pack is being replaced because data is saved when the remaining power in the backup battery becomes low.

However, the following problems can occur in this portable terminal while the battery pack is being replaced.

The backup battery is a battery that is provided to supply power for a short time while the battery pack is replaced, and is therefore usually a relatively small, low capacity battery in order to reduce cost, save space, and reduce weight. As a result, the backup battery will be depleted and operation of the portable terminal will be interrupted if replacing the battery pack is not completed within a specific time (such as several minutes) after the backup battery starts supplying power.

As described above, the portable terminal disclosed in JP-A-2003-101624 performs a data backup process when the remaining power of the backup battery becomes low so that data is not lost. While data loss can be prevented by this process that is predicated on the battery running out, interruption of work and use of the portable terminal due to the battery becoming depleted cannot be avoided. In order to comfortably continue using the portable terminal even while replacing the battery, some means of preventing the backup battery from running down is desirable.

If the battery capacity of the backup battery is small, the user must replace the battery pack quickly, and changing the battery pack may be rushed. Depending on the circumstances, such as during a meeting or in a dark environment, quickly replacing the battery pack may be difficult. Conversely, a high capacity backup battery can be used to increase the duration time of the backup battery so that the battery pack can be replaced without haste, but increasing the capacity of the backup battery leads to greater cost and increases the size and weight of the portable terminal.

SUMMARY

The present disclosure is directed to solving the foregoing problem. One non-limiting and exemplary embodiment can increase the time that is used to replace the battery pack without increasing the capacity of the backup battery.

One aspect of the disclosure is an electronic device that has: a first battery used as a drive power source for driving the electronic device; a second battery used as a drive power source instead of the first battery when the first battery cannot be used; a battery removal detection unit that detects an event of removal of the first battery from the electronic device; and a power control unit that changes the drive power source from the first battery to the second battery, and controls operation of the electronic device to reduce power consumption by the electronic device, when removal of the first battery is detected by the battery removal detection unit.

Effect of the Invention

When removal of the first battery from the electronic device is detected, this aspect of the disclosure changes the drive power source from the first battery to the second battery, and controls operation of the electronic device to reduce power consumption by the electronic device. Because power consumption from the second battery is thus suppressed when the first battery is removed, the second battery can drive the electronic device for a longer time, and more time is made available for replacing the first battery.

Other objects and attainments together with a fuller understanding of the disclosure will become apparent and appreciated by referring to the following description and claims taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows the appearance of a personal computer.

FIG. **2** is used to describe the back of the personal computer.

FIG. **3** is a block diagram of the internal configuration of the personal computer.

FIG. **4** is a flow chart of operation in the secondary battery charging mode.

FIG. **5** is a flow chart of operation when replacing the main battery.

FIG. **6** is a flow chart of operation when replacing the main battery.

FIG. **7** is a flow chart of operation when replacing the main battery.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

A preferred embodiment of a personal computer (an example of an electronic device) according to the present disclosure is described below with reference to the accompanying figures.

1. CONFIGURATION OF A PERSONAL COMPUTER

The configuration of a personal computer according to this embodiment of the disclosure is described next with reference to FIG. **1**. FIG. **1** shows the appearance of a laptop-type personal computer **1** when open. As shown in the figure, the personal computer **1** has a main body **2**, a display **3**, a keyboard **4**, and a pointing device **5**.

The personal computer **1** operates according to an operating system that controls basic operation, and application programs that control a variety of specific processes. The functions of the operating system and application programs are rendered by the programs installed in the personal computer **1**.

The main body **2** includes a storage unit that stores the operating system, application programs, and data, and an

input/output unit having input/output buffers. The user operates the personal computer **1** by inputting commands from the keyboard **4** and pointing device **5** based on information displayed on the display **3**.

FIG. **2** shows the back of the personal computer **1**. As shown in FIG. **2**(*a*), the personal computer **1** has a removable main battery **11**. The personal computer **1** also has a battery lock knob **7** that locks and unlocks the main battery **11** for removal, and an LED **8** that changes color to indicate if the main battery **11** can be removed (for example, lights green if the battery can be removed, and lights red if the battery cannot be removed).

FIG. **2**(*b*) shows when the battery lock knob **7** is released and the main battery **11** can be removed. As shown in the figure, the main battery **11** can be slid and removed from the main body **2**.

FIG. **2**(*c*) shows operating the battery lock knob **7** with the user's finger **9**. The user can lock and unlock removing the main battery **11** by sliding the battery lock knob **7** appropriately. As described below, the personal computer **1** can detect installation and removal of the main battery **11** from the state of the battery lock knob **7**.

FIG. **3** is a block diagram showing the internal configuration of the personal computer **1**. As shown in the figure, the personal computer **1** has an AC adapter **10**, a main battery **11** (first battery), and a secondary battery **12** (second battery) as power sources for personal computer **1** operation. The AC adapter **10** is an adapter that can plug into a commercial power source (outlet) in the home, for example, and converts AC voltage from the commercial supply to a specific DC voltage. The main battery **11** and secondary battery **12** are rechargeable storage batteries, and could be lithium ion batteries, lithium polymer batteries, or other type of rechargeable battery.

When the AC adapter **10** of the personal computer **1** is connected to a commercial power source, the AC adapter **10** is used as the drive power source of the personal computer **1**. When the AC adapter **10** of the personal computer **1** is not connected to a commercial power source, the main battery **11** is normally used as the drive power source. The secondary battery **12** is a battery that is used as the drive power source instead of the main battery **11** when the main battery **11** cannot be used, such as when the main battery **11** is being replaced. By having this secondary battery **12**, the personal computer **1** features a hot-swappable design enabling the main battery **11** to be replaced while the personal computer **1** is on and being used.

While the main battery **11** can be removed from the personal computer **1** and replaced in this embodiment of the disclosure, the secondary battery **12** is fixed inside the personal computer **1** and cannot be replaced. A configuration in which the secondary battery **12** is replaceable is obviously also conceivable. The secondary battery **12** has a lower charge capacity than the main battery **11**, enabling using a small rechargeable battery to save space inside the personal computer **1**.

A charging circuit **13** is connected to the main battery **11**, and this charging circuit **13** is a circuit that charges the main battery **11** using power supplied from the AC adapter **10**. Another charging circuit **14** is likewise connected to the secondary battery **12**, and this charging circuit **14** is a circuit that charges the secondary battery **12** using power supplied from the AC adapter **10** or the main battery **11**.

A booster circuit **15** is connected to the output of the secondary battery **12**, and a function of the booster circuit **15** boosts the output voltage of the secondary battery **12** to substantially the same level as the output voltage of the main battery **11**. A remaining power detection unit **16** is also connected to the secondary battery **12**, and the remaining power (remaining battery capacity) of the secondary battery **12** can be detected by a function of the remaining power detection unit **16**.

The personal computer **1** also has a power control unit **20**. The power control unit **20** is configured with an EC controller that provides power control for the entire personal computer **1**. The power control unit **20** changes the drive power source of the personal computer **1** between the AC adapter **10**, main battery **11**, and secondary battery **12**, and is connected to the charging circuits **13**, **14** and the remaining power detection unit **16**. For example, based on output from the remaining power detection unit **16**, the power control unit **20** controls the charging circuit **14** to not charge the secondary battery **12** when the remaining power of the secondary battery **12** equals or exceeds a specific threshold. The power control unit **20** also controls electrically disconnecting the secondary battery **12** from the charging circuit **14** by turning a switch **22** off when the main battery **11** is supplying power.

The power control unit **20** is connected to a battery detection unit **21**. The battery detection unit **21** is a decision circuit that detects the operation of removing the main battery **11** from the personal computer **1**, and the operation of installing the main battery **11** to the personal computer **1**.

The battery detection unit **21** determines removal and installation of the main battery **11** based on various conditions. For example, to detect attempted removal of the main battery **11**, the battery detection unit **21** uses a configuration that detects the locked or unlocked state of the battery lock knob **7** (for example, determines that the main battery **11** is being removed if the battery lock knob **7** is unlocked), and a configuration that detects opening a battery cover that covers and holds the main battery **11** inside the personal computer **1** based on the output from an internal magnetic switch (for example, determines that the main battery **11** is being removed if the battery cover is open). To detect that the main battery **11** is connected, the battery detection unit **21** uses a configuration that senses the voltage at a specific location in the circuits that are powered by the main battery **11**.

The power control unit **20** is also connected to and controls the power supply to a display controller **30** and therethrough to the display **3**, the CPU (central processing unit) **40**, and the USB (Universal Serial Bus) controller **50** and therethrough to the USB terminal **51**. The power control unit **20** is also connected to a timer **60** that keeps time.

The display **3** is any suitable information display means (display unit), such as an LCD or plasma display panel. The display controller **30** is a circuit that controls displaying content on the display **3** as controlled by the power control unit **20**.

The CPU **40** is a microprocessor that controls operation of the entire personal computer **1**.

The USB terminal **51** is a terminal for connecting a printer, mouse, external storage disc, or other external device, and driving the USB terminal **51** is controlled by the USB controller **50**.

When the main battery **11** is removed, the timer **60** counts the time past since the drive power source of the personal computer **1** changes from the main battery **11** to the secondary battery **12**.

Diodes **17***a*, **17***b*, **17***c* are reverse current prevention diodes connected to the outputs of the AC adapter **10**, main battery **11**, and secondary battery **12**. The power control unit **20** is configured to switch the power source that supplies power to the personal computer **1** between the main battery **11** and secondary battery **12** by controlling the on/off states of

switches **18***a*, **18***b*, **19***a*, **19***b*. More specifically, by synchronously controlling switch **18***a* (**19***a*) and the switch **18***b* (**19***b*) parallel connected to a diode, the power control unit **20** can switch the source of power supplied to the personal computer **1** to the main battery **11** or the secondary battery **12**.

The power control unit **20** can also run a shutdown process that safely saves data being processed to an internal hard disk or nonvolatile memory, for example, and then terminates processing by the personal computer **1** using operating system commands.

2. SECONDARY BATTERY CHARGING PROCESS

The secondary battery **12** charging process executed by the power control unit **20** is described next with reference to the flow chart in FIG. **4**. The secondary battery **12** charging process is a charging process that is required in preparation for using the secondary battery **12** as a backup battery when removing the main battery **11**.

The power control unit **20** regularly starts the secondary battery **12** charging mode (S**210**). The power control unit **20** then determines if the secondary battery **12** voltage is less than or equal to a specific threshold (S**220**). If the secondary battery **12** voltage is determined to be less than or equal to the specific threshold, control goes to the next charging process step (S**230**). If the secondary battery **12** voltage is determined to be greater than the specific threshold, charging is not necessary and the process ends.

To check if a power source for charging the secondary battery **12** is available in the charging process step S**230**, the power control unit **20** determines if the AC adapter **10** is connected to a commercial power source or if the main battery **11** voltage is greater than or equal to a specific voltage. If the AC adapter **10** is connected to a commercial power source or the main battery **11** voltage is greater than or equal to a specific voltage, control goes to the next charging process step (S**240**). If the AC adapter **10** is not connected to a commercial power source and the main battery **11** voltage is less than the specific voltage, a source of power for charging the secondary battery **12** is not available and the process ends.

In step S**240**, the power control unit **20** turns the charging circuit **14** connected to the secondary battery **12** on. As a result, charging the secondary battery **12** starts. More specifically, when the AC adapter **10** is connected to the commercial power source, the secondary battery **12** is charged from the commercial supply through the AC adapter **10**. In this situation, the main battery **11** is also charged from the commercial supply through the AC adapter **10**. If the AC adapter **10** is not connected to the commercial power source but the main battery **11** voltage is greater than or equal to the specific threshold, the secondary battery **12** is charged from the main battery **11**.

The power control unit **20** then determines if the secondary battery **12** is fully charged (S**250**). If the power control unit **20** determines the secondary battery **12** is not fully charged, the charging process continues. If the secondary battery **12** is fully charged, the power control unit **20** turns the charging circuit **14** of the secondary battery **12** off (S**260**), and ends the secondary battery **12** charging process.

3. CONTROL WHEN REPLACING THE BATTERY

The control process executed by the power control unit **20** when replacing the main battery **11** of the personal computer **1** is described next with reference to the flow charts in FIG. **5** to FIG. **7**.

In this embodiment the user has plural main batteries **11**, and when the remaining power of the main battery **11** installed in the personal computer **1** drops, removes the main battery **11** from the personal computer **1** and replaces it with another main battery **11** that was already charged using a commercial power source etc.

The power control unit **20** determines if the AC adapter **10** of the personal computer **1** is connected to the commercial power source (S**310**). If the AC adapter **10** is connected to the commercial power source, backup by the secondary battery **12** is not needed and the power control unit **20** drives the personal computer **1** with the AC adapter **10** (S**315**) and goes to step S**510** in FIG. **7**. If step S**310** determines that the AC adapter **10** of the personal computer **1** is not connected to the commercial power source, control goes to step S**320**.

In step S**320** the power control unit **20** determines if removal of the main battery **11** was detected based on the output of the battery detection unit **21**. As described above, the battery detection unit **21** determines if the main battery **11** was removed from the personal computer **1** by detecting the open/closed state of the battery lock knob **7**, or detecting opening of the battery cover based on output of a magnetic switch, for example. If the power control unit **20** determines the main battery **11** was removed, control goes to step S**330**. If removal of the main battery **11** was not detected, step S**320** repeats. While the power control unit **20** waits and repeats step S**320**, other program operations can be performed.

In step S**330**, the power control unit **20** determines if the secondary battery **12** voltage equals or exceeds a maximum discharge voltage. If the secondary battery **12** voltage is less than the maximum discharge voltage, the power control unit **20** warns the user because the secondary battery **12** cannot be used to drive the personal computer **1** (S**335**). The power control unit **20** also executes an operating system shutdown process to protect user data from loss due to battery depletion, and puts the system to sleep (S**340**).

Note that the user can be warned in step S**335** by, for example, presenting suitable content on the display **3**. The LED **8** that indicates the position of the battery lock knob **7** can be used with great effect to warn the user because the probability that the user attempting to remove the main battery **11** using the battery lock knob **7** will see the LED **8** is high. A specific example of warning is to warn the user by causing the LED **8** to blink red. The method of assuring the reliability of the secondary battery **12** is not limited to detecting the battery voltage, and other methods may also be used. For example, the power control unit **20** could be configured to determine deterioration of the secondary battery **12**. For example, when the power control unit **20** determines that the secondary battery **12** has deteriorated, a warning with the LED **8** is done. Battery deterioration can be determined by measuring the rate of decrease in the output voltage during discharge, and determining the battery has deteriorated if the voltage drop is faster than a specific threshold. Note that issuing a warning with the LED **8** can be done in a step other than step S**320**. For example, a warning could be presented constantly if the reliability of the secondary battery **12** is low.

If in step S**320** the voltage of the secondary battery **12** is greater than or equal to the maximum discharge voltage, the power control unit **20** changes the drive power source of the personal computer **1** from the main battery **11** to the secondary battery **12** by controlling switches **18***a*, **18***b*, **19***a*, **19***b* (S**350**), and goes to step S**410** in FIG. **6**. At this time the timer **60** starts counting the time past from when the drive source changes from the main battery **11** to the secondary battery **12**. The LED **8** is also driven green to notify the user that the main battery **11** can be removed.

To reduce power consumption by the personal computer **1**, the power control unit **20** sets the display brightness of the display **3** to the lowest level through the display controller **30** (S**410**). Note that while this embodiment sets the display brightness of the display **3** to the lowest level in order to minimize power consumption, the display brightness does not need to be set to the lowest level, and power consumption can be reduced by lowering the display brightness of the display **3** from the current level.

The power control unit **20** also sets the CPU **40** to a power conservation mode in order to reduce the power consumption of the personal computer **1** (S**420**). The power control unit **20** could switch to this power conservation mode by lowering the drive frequency of the CPU **40**, lowering the drive voltage of the CPU **40**, or using another desirable power conservation method.

To reduce power consumption by the personal computer **1**, the power control unit **20** also disconnects external devices by disabling use of the USB terminal by means of the USB controller **50** (S**430**). Note, further, that while disabling use of the USB terminal is described here, power consumption can also be reduced by disabling use of IEEE-1394 connectors and other external connectors.

The power control unit **20** in this embodiment of the disclosure executes each of steps S**410** to S**430** to reduce the power consumption of the personal computer **1**, but the power control unit **20** could execute only one or two of steps S**410** to S**430**. Further alternatively, the power control unit **20** could use steps other than those described in steps S**410** to S**430** to reduce power consumption by the personal computer **1**.

Based on output of the battery detection unit **21**, the power control unit **20** then determines if installation of the main battery **11** is completed (S**440**). If installation of the main battery **11** is determined not complete, control goes to step S**450**. If installation of the main battery **11** is complete, replacing the main battery **11** is completed and the role of the secondary battery **12** has ended. The power control unit **20** therefore changes the drive power source of the personal computer **1** from the secondary battery **12** to the main battery **11** using switches **18***a*, **18***b*, **19***a*, **19***b* (S**445**), and control goes to step S**510**.

In step S**450**, the power control unit **20** measures the time past since the drive source was switched from the main battery **11** to the secondary battery **12** in step S**350** based on the output of the timer **60**, and determines if a first specific time (such as 2 minutes) has past since the secondary battery **12** started discharging. If this step determines that the first specific time (2 minutes) has not past since the secondary battery **12** started discharging, the power control unit **20** returns to step S**440**. If the first specific time (2 minutes) has past since the secondary battery **12** started discharging, the power control unit **20** asserts a power supply switch (S**460**). Power consumption by the personal computer **1** drops as a result of this assertion.

Next, the power control unit **20** measures the time past from when the drive source switched from the main battery **11** to the secondary battery **12** in S**350** based on output from the timer **60**, and determines if a second specific time (such as 5 minutes) has past since the secondary battery **12** started discharging (S**470**). If this step determines that the second specific time (5 minutes) has not past since the secondary battery **12** started discharging, the power control unit **20** returns to step S**440**. If the second specific time (5 minutes) has past since the secondary battery **12** started discharging, the power control unit **20** goes to the next step (S**480**).

The power control unit **20** then determines based on the output of the remaining power detection unit **16** if the power reserve of the secondary battery **12** is less than or equal to a specific threshold (S**480**). As a result, if the power reserve of the secondary battery **12** is greater than the threshold, the backup operation can continue using the secondary battery **12** and the power control unit **20** therefore returns to S**440**. However, if the power reserve of the secondary battery **12** is less than or equal to the threshold, the backup operation cannot continue using the secondary battery **12**, and the power control unit **20** executes the operating system shutdown process to protect user data from loss, and puts the system to sleep (S**490**).

As described above, the power control unit **20** executes a shutdown process that turns device power off (S**490**) when the secondary battery **12** is used as the drive power source, the elapsed time measured by the timer **60** exceeds a specific time (S**470**), and the power reserve of the secondary battery **12** is less than or equal to a specific threshold (S**480**). However, the power control unit **20** could execute the shutdown process that turns device power off regardless of the power reserve in the secondary battery **12** if the elapsed time measured by the timer **60** exceeds a specific time. Further alternatively, the power control unit **20** could execute the shutdown process that turns device power off regardless of the elapsed time measured by the timer **60** if the power reserve of the secondary battery **12** drops to less than or equal to a specific threshold.

In other words, the power control unit **20** could execute the shutdown process that turns device power off when the secondary battery **12** is used as the drive power source if the main battery **11** has not been installed in the personal computer **1** by the time the elapsed time measured by the timer **60** exceeds a specific time.

Control by the power control unit **20** after step S**510** is described next with reference to the flow chart in FIG. **7**. This control process executes when step S**310** in FIG. **5** above determines the AC adapter of the personal computer **1** is connected to the commercial supply, or installation (replacement) of the main battery **11** is determined completed in S**440** in FIG. **6**, because the personal computer **1** does not need backup by the secondary battery **12**.

Because the personal computer **1** is already driven by the AC adapter **10** or a new main battery **11**, sufficient power can be supplied, and there is no need to sacrifice performance in order to reduce power consumption. The power control unit **20** therefore controls the display controller **30** to change the display brightness of the display **3** from the darkened state to normal brightness (S**510**). The power control unit **20** also boosts the drive frequency or drive voltage of the CPU **40**, and changes from the power conservation mode to the normal power mode (S**520**). The power control unit **20** also controls the USB controller **50** to enable using the USB terminal **51**, and enables connecting external devices (S**530**).

The power control unit **20** thus completes the control process used when the user replaces the main battery **11** of the personal computer **1**.

4. CONCLUSION

This embodiment of the disclosure discloses a personal computer **1** that has a main battery **11** used as power source for driving the personal computer **1**, a secondary battery **12** that is used as a power source in place of the main battery **11** when the main battery **11** cannot be used, a battery detection unit **21** that detects an event of removal of the main battery **11**, and a power control unit **20** that changes the power source from the main battery **11** to the secondary battery **12**, and

controls operation of the personal computer **1** to reduce power consumption based on the output of the battery detection unit **21**.

Thus configured, when removing the main battery **11** from the main device is detected, the power source changes from the main battery **11** to the secondary battery **12** based on removal of the main battery **11**, and operation of the personal computer **1** is controlled so that power consumption by the personal computer **1** is reduced. As a result, power consumption from the secondary battery **12** is suppressed when the main battery **11** has been removed, the duration time of the secondary battery **12** is thus extended, and more time is available for replacing the main battery **11**.

The foregoing embodiment describes a personal computer **1** as an example of an electronic device according to the disclosure. The disclosure is not so limited, however, and can be broadly applied to battery-powered electronic devices including cell phones, video cameras, portable televisions, and portable BluRay disc players.

INDUSTRIAL APPLICATION

The electronic device disclosed herein can be used in devices including personal computers, digital cameras, movie cameras, portable televisions, cell phones, and portable BluRay disc players.

The disclosure being thus described, it will be obvious that it may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

What is claimed is:

1. An electronic device comprising:

a first battery used as a drive power source for driving the electronic device;

a second battery used as the drive power source instead of the first battery when the first battery cannot be used;

a battery removal detection unit that detects an event of removal of the first battery from the electronic device;

a power control unit that changes the drive power source from the first battery to the second battery, and controls operation of the electronic device to reduce power consumption by the electronic device, when removal of the first battery is detected by the battery removal detection unit; and

a timer that counts an elapsed time from when the drive power source changes from the first battery to the second battery,

wherein the power control unit executes a shutdown process that turns electronic device power off when the second battery is used as the drive power source and the first battery has not been installed in the electronic device even though the elapsed time counted by the timer exceeds a specific time;

wherein the power control unit asserts a power supply switch after passing of a first time threshold and executes a shutdown process that turns electronic device power off after passing of a second time threshold, the second time threshold being longer than the first time threshold, when the second battery is used as the drive power source and the first battery has not been installed in the electronic device even though the elapsed time counted by the timer exceeds the specific time.

2. The electronic device described in claim **1**, wherein:

the first battery is held inside the electronic device by being covered with a battery cover; and

the battery removal detection unit detects removal of the battery cover as the event of removal of the first battery from the electronic device.

3. The electronic device described in claim **1**, wherein:

the second battery has lower battery capacity than the first battery.

4. The electronic device described in claim **1**, further comprising:

a remaining battery power detection unit that detects the remaining power in the second battery;

wherein the power control unit executes a shutdown process that turns electronic device power off when the second battery is used as the drive power source and the remaining power of the second battery detected by the remaining battery power detection unit is less than or equal to a specific threshold.

5. The electronic device described in claim **1**, wherein:

the second battery is a rechargeable battery;

the electronic device has a charging circuit that charges the second battery; and

the charging circuit does not charge the second battery when the remaining power of the second battery is greater than or equal to a specific threshold.

6. The electronic device described in claim **5**, wherein:

the second battery is electrically disconnected from the charging circuit while power is being supplied by the first battery.

7. The electronic device described in claim **1**, further comprising:

a display unit that displays information;

wherein the power control unit reduces the display brightness of the display unit to reduce power consumption by the electronic device.

8. The electronic device described in claim **1**, further comprising:

a central processing unit that controls electronic device operation;

wherein the power control unit reduces the drive frequency or the drive voltage of the central processing unit in order to reduce power consumption by the electronic device.

9. The electronic device described in claim **1**, further comprising:

a terminal that can connect to an external device;

wherein the power control unit disables connecting the external device through the terminal in order to reduce power consumption by the electronic device.

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